REMARKS

I. Election of Claims

The Applicant has cancelled claims 2-10, 13, and 15-74 and reserves the right to file divisional applications directed to the non-elected claims. As such, claims 1, 11-12, 14 and new claims 75-78 are currently pending.

The amendments to the claims have been made in an effort to lend greater clarity to the claimed subject matter and to expedite prosecution. These amendments should not be taken to indicate the Applicant's agreement with, or acquiescence to the rejections of record. Also, Applicant expressly reserves the right to pursue the inventions disclosed in the subject application, in a related application.

II. Response to the Objections to the Claims 1, 3-6, 16 and 73, and to the Rejection the Claims 7-9, 73 and 74, under 35 U.S.C. 112, 2nd Paragraph

The Applicant has amended claim 1 to remove the hyphens, as requested by the Examiner. The remaining claims that were objected to and/or rejected have been cancelled.

Accordingly, Applicants request withdrawal of the objections and the rejections of the claims under 35 U.S.C. §112, 2nd paragraph.

III. Response to the Rejection under 35 U.S.C. §102(b) of Claims 1-12, 14-16, 70, and 72-74, as being anticipated by the Kishimoto et al. (US 6,242,686) reference.

Claim 1 has been amended to recite that the absorber layer of the photovoltaic cell comprises a thin film silicon (tf-Si) alloy based solar cell including at least one of amorphous silicon (a-Si:H) based solar cell, amorphous silicon germanium (a-$Si_{(1-x)}Ge_x$:H) based solar cell, nanocrystalline silicon (nc-Si:H) based solar cell, microcrystalline silicon (μc-Si:H) based solar, polycrystalline silicon (poly-Si:H) based solar cell, or other combinations and mixtures thereof.

Also, claim 1 now recites that the first and second p-type sub-window layers have substantially the same chemical composition but have different bandgaps. As presently claimed, the second sub-window layer has a bandgap wider than the bandgap of the first sub-window layer, and there is a minimal mismatch between the bandgap of the first sub-window layer and the bandgap of the absorber layer that is adjacent to the first sub-window

layer. Support for such amendments is found in the specification and in the Figures.

The Kishimoto et al. reference relates to photovoltaic devices having a p-layer that is formed of two sub p-layers where the sub p-layer adjacent to an absorber layer (i-layer) is made without positively incorporating a doping impurity in that p-layer. The Kishimoto et al. reference is concerned with simplifying the manufacturing process for making such devices.

The Kishimoto et al. reference specifically deals with a variation of doping impurities between the two sub p-layers with the sub p-layer adjacent to the absorber layer (i-layer) having lower doping. Further, the Kishimoto et al. reference provides a device in which the p-layers are formed prior to the formation of the i-layer.

Specifically, the Kishimoto et al. sub p-layer adjacent to the i-layer is formed after the sub p-layer that is adjacent to a transparent conductor layer. Therefore, the sub p-layer adjacent to the i-layer is lightly doped due to the fact that it is formed in the same deposition chamber right after the deposition of a heavily doped sub p-layer, even without incorporation of doping gas in the process gas mixture. This Kishimoto et al. approach would not work in the case wherein the sub p-layer adjacent to the i-layer is formed prior to the heavily doped sub p-layer.

In contrast, the instant invention is different from the Kishimoto patent at least because the doping gases for both sub p-layers are kept constant such that the first and second p-layers have substantially the same chemical composition. In the instant invention, the two sublayers provide a change in the bandgap of the sub p-layer adjacent to the i-layer so that the bandgap mismatch at the p-i interface is minimized. There is no teaching, suggestion or motivation in the Kishimoto et al. reference of such feature.

In addition, new claims describe embodiments (i) where the first sub-window layer is formed by deposition at a first temperature, and the second sub-window is formed by deposition at a second temperature that is lower than the first temperature; and (ii) where the sub p-layer adjacent to the i-layer is formed after the i-layer is formed. There is also no teaching, suggestion or motivation in the Kishimoto et al. reference of such features.

Further, remaining claims 11-12 and 14 depend from amended claim 1 and should be allowable for at least the same reasons as set forth above.

Accordingly, Applicants request withdrawal of the rejections of the claims under 35 U.S.C. §102(b).

IV. Response to the Rejection under 35 U.S.C. §102(b) of Claims 1-9, 11, 12, 14, and 15, as being anticipated by Sano et al. (US 2001/0037824), now US 6,566,594.

As fully set forth above, claim 1 now recites an embodiment where the first and second p-type sub-window layers have different bandgaps, where the second sub-window layer has a bandgap wider than the bandgap of the first sub-window layer, and where there is a minimal mismatch between the bandgap of the first sub-window layer and the bandgap of the absorber layer that is adjacent to the first sub-window layer.

The Sano et al. reference relates to a device having an intermediate layer between the p- and TCO- interface and also relates a device having an interfacial layer at the p-i interface. The Sano et al. interfacial layer at p-i interface is present to improve the device open circuit voltage (Voc). Additionally, in the Sano et al. reference, the interfacial layer at the p-i interface is applied prior to the formation of i-layer. The benefit of such an interfacial layer is NOT on reducing the bandgap mismatching at the p-i interface but on the use of a thin layer to improve Voc.

In contrast, in the instant invention, the p-type layer (with two sub p-layers where the first sub p-layer adjacent to the i-layer reduces bandgap mismatch) improves the solar cell fill factor of the inventive device.

In addition, new claims describe embodiments (i) where the first sub-window layer is formed by deposition at a first temperature, and the second sub-window is formed by deposition at a second temperature that is lower than the first temperature; and (ii) where the sub p-layer adjacent to the i-layer is formed after the i-layer is formed. There is also no teaching, suggestion or motivation in the Sano et al. et al. reference of such features.

Further, remaining claims 11-12 and 14 depend from amended claim 1 and should be allowable for at least the same reasons as set forth above.

Accordingly, Applicants request withdrawal of the rejections of the claims under 35 U.S.C. §102(b).

V. Response to the Rejections under 35 U.S.C. §102(b) of Claims 1-9, 11, 12, 15, 16, 70, and 72-74, as being anticipated by Yamagishi et al. (US 5,032,884).

As fully set forth above, claim 1 now recites an embodiment where the first and second p-type sub-window layers have different bandgaps, where the second sub-window layer has a bandgap wider than the bandgap of the first sub-window layer, and where there

is a minimal mismatch between the bandgap of the first sub-window layer and the bandgap of the absorber layer that is adjacent to the first sub-window layer.

The Yamagishi et al. reference relates to a pin semiconductor device where the dopant or impurities concentration in the p-layer varies so that the sub p-layer (or interlayer as described therein) at the p-i interface has a smaller doping concentration.

Additionally, the interlayer in the Yamagishi et al. reference uses various materials having different chemical compositions. Also, in the Yamagishi et al. reference, there is a gradual change in doping concentration from the p-i interlayer to the bulk of the p-layer. The Yamagishi et al. interlayer thus acts to increase solar cell Voc.

In contrast, the instant invention does not relate to doping variation or doping gradient. Further, the present invention does not relate to the use of different chemical composition at the p-i interface. Rather, the purpose and benefit of the sub p-layer at p-i interface is to reduce bandgap mismatch and to improve solar cell fill factor by having different band gap conditions instead of changed doping or chemical compositions. In contrast, in the instant invention, the p-type layer (with two sub p-layers where the first sub p-layer adjacent to the i-layer reduces bandgap mismatch) improves the solar cell fill factor of the inventive device.

In addition, new claims describe embodiments (i) where the first sub-window layer is formed by deposition at a first temperature, and the second sub-window is formed by deposition at a second temperature that is lower than the first temperature; and (ii) where the sub p-layer adjacent to the i-layer is formed after the i-layer is formed. There is also no teaching, suggestion or motivation in the Sano et al. et al. reference of such features.

Further, remaining claims 11-12 and 14 depend from amended claim 1 and should be allowable for at least the same reasons as set forth above.

Accordingly, Applicants request withdrawal of the rejections of the claims under 35 U.S.C. §102(b).

VI. Response to the Rejection of claims 13 and 71 over one or more of Sano et al (US 2001/ 0037824, now US 6,566,594), Nakanishi, Yamagishi et al., Kishimoto et al., and Sano et al. (JP 08-051227).

In view of the cancellation of claims 13 and 71, the Applicant submits that such rejections are moot, and the Examiner is respectfully requested to withdraw such rejections.

VII. Newly added claims recite further patentably distinct embodiments

Applicants have added claims which further describe additional embodiments of the present invention. Support for these claims is found in the specification and drawings. Therefore, the Examiner is respectfully requested to allow these claims.

VIII. Conclusion

None of the cited references addressed, let alone purported to solve, the problem of a mismatch between the bandgap of a p layer and an absorber layer, which problem is solved by the present invention.

Accordingly, Applicants request withdrawal of the rejections of the claims under 35 U.S.C. §§ 112, 102(b) and 103(a).

In view of the above amendments to the claims and the remarks herein, it is submitted that the specification, drawings and claims are in proper form. Accordingly, Applicants respectfully request reconsideration and withdrawal of the objections and rejections of record, and allowance of all claims.

IX. Request for Telephone Interview

As a final matter, if the Examiner has any suggestions concerning different claim phraseology that, in the opinion of the Examiner, more accurately defines the present invention, prior to issuance of another Office Action, Applicant's attorney requests the courtesy of a telephone interview at the Examiner's earliest convenience to discuss the application. Applicant's attorney may be contacted at 419-255-5900.